GREAT NORTHERN ELEVATOR
(Mutual Elevator)
(Pillsbury Company Elevator)
250 Ganson Street
Buffalo
Erie County
New York

HAER No. NY-240

WRITTEN HISTORICAL AND DESCRIPTIVE DATA
REDUCED COPIES OF MEASURED DRAWINGS
PHOTOGRAPHS

Historic American Engineering Record
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HISTORIC AMERICAN ENGINEERING RECORD

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(Mutual Elevator)
(Pillsbury Company Elevator)
HAER No. NY-240

Location: 250 Ganson St., Buffalo, Erie County, New York

Date: Building permit issued March 31, 1897

Designer: Max Toltz and D. A. Robinson

Builders: D. A. Robinson, Chicago; Riter Conley, Pittsburgh, steel fabrication; Buchan Bros., steel erectors

Status: Not in use

Significance: The grain elevators of Buffalo comprise the most outstanding collection of extant grain elevators in the United States, and collectively represent the variety of construction materials, building forms, and technological innovations that revolutionized the handling of grain in this country.

Project Information: The documentation of Buffalo's grain elevators was prepared by the Historic American Engineering Record (HAER), National Park Service, in 1990 and 1991. The project was co-sponsored by the Industrial Heritage Committee, Inc., of Buffalo, Lorraine Pierro, President, with the cooperation of The Pillsbury Company, Mark Norton, Plant Manager, Walter Dutka, Senior Mechanical Engineer, and with the valuable assistance of Henry Baxter, Henry Wollenberg, and Jerry Malloy. The HAER documentation was prepared under the supervision of Robert Kapsch, Chief, HABS/HAER, and Eric DeLony, Chief and Principal Architect, HAER. The project was managed by Robbyn Jackson, Architect, HAER, and the team consisted of: Craig Strong, Supervising Architect; Todd Croteau, Christopher Payne, Patricia Reese, architects; Thomas Leary, Supervising Historian; John Healey, and Elizabeth Sholes, historians. Large-format photography was done by Jet Lowe, HAER photographer.

Historians: Thomas E. Leary, John R. Healey, Elizabeth C. Sholes, 1990-1991

This is one in a series of HAER reports for the Buffalo Grain Elevator Project. HAER No. NY-239, "Buffalo Grain Elevators," contains an overview history of the elevators. The following elevators have separate reports:

NY-240 Great Northern Elevator
NY-241 Standard Elevator
NY-242 Wollenberg Grain & Seed Elevator
NY-243 Concrete-Central Elevator
NY-244 Washburn Crosby Elevator
NY-245 Connecting Terminal Elevator
NY-246 Spencer Kellogg Elevator
NY-247 Cooperative Grange League Federation
NY-248 Electric Elevator
NY-249 American Elevator
NY-250 Perot Elevator
NY-251 Lake & Rail Elevator
NY-252 Marine "A" Elevator
NY-253 Superior Elevator
NY-254 Saskatchewan Cooperative Elevator
NY-256 Urban Elevator
NY-257 H-O Oats Elevator
NY-258 Kreiner Malting Elevator
NY-259 Meyer Malting Elevator
NY-260 Eastern States Elevator

In addition, the Appendix of HAER No. NY-239 contains brief notations on the following elevators:

Buffalo Cereal Elevator
Cloverleaf Milling Co. Elevator
Dakota Elevator
Dellwood Elevator
Great Eastern Elevator
Iron Elevator
John Kam Malting Elevator
Monarch Elevator
Pratt Foods Elevator
Ralston Purina Elevator
Riverside Malting Elevator

The president of the Great Northern Railroad, J. J. Hill, provided the impetus for the construction of an innovative fireproof elevator to transfer grain from his steamships for the onward dispatch, primarily by railroad, from Buffalo. The Great Northern Elevator was one of a new generation of economically and operationally successful steel elevators, and shared with the contemporary Electric Elevator a pioneering application of electric power to elevator functions.[1]

Although iron and steel had been applied to grain storage bins before the 1890s, the technology had not been widely adopted due to the high initial costs, misgivings about the materials' suitability for grain storage and the relative cheapness and ease of wooden construction. Iron and steel were applied to several pioneering elevator designs during the 1860s. In 1861 an iron-binned elevator was built in Brooklyn, New York. Seven years later the iron-binned and brick-clad Plymton Elevator was constructed in Buffalo, and, also in 1868, the first steel-binned elevator was built at Girard Point, Philadelphia. However it appears that there was little subsequent application of either iron or steel to grain storage. The availability of cheap open hearth steel from the late 1880s promised a revival of interest in metal grain storage. It is thought that a derivative of a patent by a man named Weber was employed in the construction of the Electric Elevator.

A notable pre-1897 patent for steel bins was that of Edward O. Fallis. His design, patented in 1895, featured freestanding hexagonal bins. The walls were of double thickness with steel sheets shallowly curved, the outer sheet curved outward and the inner sheet curved inward. A tubular steel column was placed at every corner of the hexagon, and into this the wall sheets were slotted. Provision was made for insulation and ventilation within the cavity created between the two wall sheets.

The Great Northern Elevator was built to the general design of the noted Chicago elevator builder D. A. Robinson, although the idea of raising the bins on columns may have come from J. J. Hill himself. Robinson was also responsible for the design of the machinery within the elevator. Robinson was thirty-five years old at the time of his appointment as "Engineer and Superintendent of Construction," and had been responsible for the construction of about 13 million bushels of elevator capacity. Much of his experience to this date had been in timber construction, for which he held a number of patents, particularly in the area of countering the substantial structural movements inherent in this form of construction.

The design work was carried out in collaboration with Max Toltz, bridge engineer to the Great Northern Railroad, who was appointed "Consulting Engineer" during construction. Toltz appears to have been responsible for the detailed working of Robinson's general designs. This collaborative effort was to culminate in the granting of a number of joint patents covering the various innovations introduced in the Great Northern. A patent granted in 1897, for example, detailed the construction of the bins, particularly an annular ring girder raised on columns above floor level within which the main cylindrical body of the bin rested, and from which hung the hemispherically shaped bin bottoms. Another patent, also granted in 1897, dealt with the vertical sub-division of the bins by the addition of hemispherically shaped dividers within the bins.

Although the Great Northern contained many novel features, the elevator was a structure in transition. The provision of a full height basement lacking horizontal transfer systems is an enigma, particularly since the contemporaneous and structurally less sophisticated Electric Elevator featured such systems. Previously such basements had been constructed to provide for the direct loading of railroad cars within the elevator, yet with the exception of a short length of internal track for grain dumping, all railroad loading functions were carried out below the car loading canopy attached to the outside of the building.

In the absence of basement conveying systems, lofting legs had to be provided along the length of the building and positioned so that grain drawn off from any one bin could be spouted directly by gravity to a convenient elevator boot tank for reelevation to the cupola for weighing and loading out (shipment). A lofty basement was required not only to provide the necessary spouting angles from the bin bottoms, but also to allow for the manipulation of the complex articulated spouting equipment that enabled all bins to feed to an elevator boot. The lofting requirements dictated by basement operations determined the necessity of a full height cupola the length of the building.

Contemporary journals remarked on the speed at which the building was conceived and executed. A building permit was issued in February of 1897 and work on the excavation of the site was underway by the end of that month. The building was sufficiently complete to receive its first cargo on September 29, 1897. The main outline of the design was barely sketched out when excavation began, detailed plans being worked out as needed. Robinson is said to have commenced work on the drawings in April of 1897, and surviving signed plans show that he was working on the designs until at least July.

By the end of March, despite ground frozen so hard as to require dynamite to break it up, the entire site had been excavated to the required depth of 8'. Piling commenced after the excavations had been completed. Six thousand hemlock piles were driven by six steam pile drivers. The piling operations took about six weeks and were completed by mid-April. With the completion of piling, work commenced on the substantial masonry foundations.

After completion of the foundation, steel erection commenced. Substantial elements of the steel work were prefabricated in Pennsylvania at the shops of the steel contractor Ritter Conley Company. The basement columns were built up and delivered to the site complete, while the ring girders were shop fabricated and delivered to the site in four sections. The shipping bins arrived at the site as completed cylinders up to about 25' long. The components for the storage bins were delivered to the site on a plate by plate basis. The plates for the cylindrical sections of the bin had been rolled to shape, and the holes for the fastenings punched and reamed. The plates for the bin bottoms were shop sheared to shape, punched flat and forged to profile at white heat between the dies of a 400-ton hydraulic press. The columns, weighing some 10-1/2 tons, were lifted into place by derricks and held there by anchor bolts. The segments of the ring girders, weighing about five tons, were then lifted into place and riveted together. The first two rows of basement columns, complete with ring girders, were in place by the end of May, and the completion of this job took approximately seven weeks. By the middle of July, the erection of the columns and girders was virtually complete, and the first two rows of bins were in place.

The shipping bins varied in depth from 22' to 53'. The bin arrangements designed by Robinson wasted about 20 percent of the potential volume of enclosed space. This deficiency was corrected at a later date by the addition of sixty small elliptically shaped bins within the spaces between the main and interstitial bins. Four such bins were installed in the gaps between interspace bins and the four adjoining main bins. The date of this additional capacity is not known, but the extension was probably carried out during the remodelling works commissioned by Pillsbury upon acquisition in 1922. An updated Sanborn map from that era, however, while showing modifications to the marine towers carried out at that time, failed to note any additional storage capacity.

Unlike later concrete elevators, the bins were designed to withstand full fluid pressures. Apparently the theories on the behavior of grain in deep bins were sufficiently speculative at this date for Robinson and Toltz to behave with due prudence and,

in the light of subsequent experience, to considerably overspecify the material requirements.

The main bins consisted of a 65' cylindrical section above the ring girder together with a 21' tapering bin bottom below the ring girder. The upper part of the bin bottom was hemispherical in profile while the lower portion was of conical section. The main cylindrical part of the bin consisted of thirteen rings of steel plate. Each ring was 5' deep and the thickness of successive rings decreased from 1/2" at the bottom to 3/16" at the top. The joints between rings were made by bolted lap joint. The width of the lap joint decreased from 5-1/4" to 4-1/2" from bottom to top. Each ring was comprised of eight annular segments.

The segments butted against each other with the joint made by bolted fillet plates. The fillet plates were placed both internally and externally and were of the same specification as the main plates in that segment. The bins were stiffened both at their tops and 15' below by an internal ring of channel steel. The bottom of the bins was fabricated of three rings of 1/2" plate. In the lowest section, twelve wedge-shaped plates were riveted together to form the conical section of the bin bottom. The upper two rings were composite profiled wedge-shaped plates riveted together to form the hemispherical section of the bin bottom. All bin bottom connections were made by riveted lap joints.

Eight central main bins were modified immediately after construction to provide for the storage of grain in smaller lots. The method of sub-division was designed according to one of Robinson and Toltz's patents. Each bin was sub-divided vertically into four compartments by hanging from the cylindrical bin walls three hemispherical assemblies analogous to the bin bottoms. Supply spouts fed each bin from the bin floor, while draw-off took place through a shared 30" centrally placed tube. The construction of the interspace bins, composed of thirteen rings with four plates each, was analogous to that of the main bins. The cylindrical section of each bin extended over 67', and the bin bottom was 9' deep. The bin bottom was almost entirely hemispherical in section and lacked the noticeable conical apex present in the main bins. The bin tops were covered by plates riveted to I-beams that rested on the upper stiffening ring. The plates extended across the entire structure to form a continuous bin floor.

Both main and interspace bins were supported on a network of basement columns. The columns were of box girder form built up from medium steel plate. They were designed to carry 700 tons, including portions of the load of the grain, the dead load of the

bin steel work, and the dead, live and wind loads from the cupola. Each column was 25'-6" tall and eight such columns were placed below every main bin to directly support the annular steel ring girder within which the bins rested. Columns measuring 30" x 29" were located at the points where the bins were almost in tangential contact. Four such columns were located below any one main bin, and four columns measuring 18" x 22" were placed at intermediate points between the larger columns.

In addition to supporting a part of the main bin ring girder, the intermediate columns also supported the interspace bin ring girders. Four such columns, one from each of the four main bins that form the interspace, were used to support interspace ring girders. The ring girders bore directly on the tops of the columns and were located around the outside of the main bins at the point where the bin cross section changed from cylindrical to hemispherical. The cylindrical part of the bin rested within the girder, and the hemispherical bin bottom was hung from it. All connections between the various components were made by rivets.

The ring girders were designed to distribute the bin loading on the columns more evenly about the circumference of the bin, and could carry twenty tons per linear foot. The ring girders for the main bins were 6' deep, and those for the interspace bins were 3'-8" deep. The webs of these girders were stiffened by flanges of 5" x 5" angles at the points of support, and by 3-1/2" x 3-1/2" angles elsewhere. The shipping bins were supported on plates attached to the main bins and rail set within the brick curtain walling. They imposed the only external loading upon the brick curtain walling. The additional elliptical bins were set on beams attached to main and interspace bins.

The basement columns bore on foundation piers of Kettel River Sandstone. The base of each pier was 9' square, and was made up of four stepped courses capped by a single 5' square stone, upon which rested a cast iron base plate which located the base of the columns. The foundation piers in turn bore on groups of twenty to thirty, 12"- 14" diameter hemlock piles driven on 24" centers. These were arranged so that no pile carried more than twenty-five tons. The piles extended to rock at depths of between 45' and 50'. The pier masonry was laid on a grillage of 12" x 4" timber bolted to the top of the piles. The basement columns extended upward between the bins to support the structure of the cupola and the machinery within. The columns rested directly on the ring girder. They were of built up H-sections to the top of the bins, Z-bars to the scale floor, and H-sections again to the roof.

The cupola consisted of a structural steel trussed framework

clad in corrugated iron and rising to a height of 184'. The entire weight of the structure was carried by the extensions of the basement columns. The first floor of the cupola extended across the full area of the building and contained the spouts and conveyors necessary to distribute the grain to any bin. All subsequent floors were contained within the narrow monitor. The second floor contained ten 1,200-bushel scale hoppers, and the third floor housed seventeen 900-bushel garners and ten 1,600-bushel garners. The upper floor contained the elevator heads. The brick curtain walling was of pier and panel form. The piers were 4' wide, and the panels 15'-7-1/2" wide. The first 12' of wall was 25-1/2" thick, the next 12' to 28' of wall was 21-1/2" thick, and above this point the wall was made up of 21" thick, 4' wide piers and 17" thick, 15'-7-1/2" wide panels.

As originally constructed, the elevator was equipped with three movable marine towers. These were of structural steel clad in corrugated iron and measured 30' x 20' and 125' tall. The sides of the towers were slightly tapered and featured hipped roofs. After the southern and middle towers blew over during a storm in 1922, they were replaced by two new 145' high towers built by Monarch Engineering. The replacement towers had straight sides and a flat roof. The remaining original tower appears to have been retained for some time, and this northerly tower was certainly in place in the late 1920s. While the towers were being replaced, the opportunity was taken to rebuild the dock in reinforced concrete.

BUSINESS HISTORY

The Great Northern Grain Elevator was the premier Eastern grain facility of railroad magnate James J. Hill's Great Northern Railroad. Built in 1897, the elevator was the third of its type to be designed by elevator architect Max Toltz. It was considered the most modern of his facilities for its capacity of three million bushels, its use of huge steel bins, and its fully electrically powered machinery.[2] The chief focus of the Buffalo construction project was to fireproof the building by using steel bins to reduce the chance of outside sparks from lanterns or other sources of flame. The Buffalo elevator was the first to adopt the new steel bins, but even these sometimes caused grain to "sweat," thereby producing gases that could spontaneously combust. Toltz's design offset that contingency by allowing workers to transfer grain from unaffected cylinders to dry, empty bins. Such protective measures reduced the Great Northern's fire insurance premium by $25,000 per year.[3]

More significant than the physical design of the building,

however, were the forces that brought one of the most important railroad lines in the western and Great Plains states to Buffalo. The rail line itself did not extend eastward, but the growth of the Great Northern as a corporation outstripped the physical dimensions of the company's property. The expansion of the Great Northern Railroad is a leading example of the diversification and expansion of American capital during the 1890s. The railroad's establishment of an important facility at the eastern end of the Great Lakes was a typical action characteristic of the growth of business empires in that era.

There is no question that Hill's primary interest lay in expansion westward from the Mississippi River. A Canadian Scot by birth, Hill migrated to Minnesota Territory in the early 1850s when he was only eighteen. He began his spectacular career as an industrial baron under very modest conditions, working as a shipping agent for a new railroad branch based in St. Paul. Through Hill's hands passed the golden bounty of grains, cereals, and flour that emerged from the verdant soils of the northern Great Plains. In the early days of Hill's career, only a few railroads and a handful of hardy settlers produced the harvest that trickled east to urban markets. But after the Civil War, the flow of immigrants that followed the rail lines' expansion became a stream, then a river, then a flood.

In 1873, however, one of the two chartered rail lines established to open the western plains could not continue to operate, despite the huge volume of crops demanding transport. The St. Paul & Pacific (SP&P) collapsed, giving James J. Hill his entree into the world of railroad ownership as well as shipping. The rail line was particularly desirable since it had both a state charter and a Homestead Act grant, the latter of which had endowed the railroad with five million acres in Minnesota to develop. The railroad's weaknesses stemmed from overcapitalization; SP&P had $28 million outstanding in a variety of bonds upon which it could no longer pay the interest. Company expenses vastly outran profits, and no more financing was available.

In 1874 the railroad was in receivership, its frantic bondholders willing to settle the debt at almost any price just to recoup what they could of their principal. Through a two-year series of confidential arrangements, Hill quietly absorbed the now-undesirable bonds at mere pennies on the dollar. He observed the steady influx of new migrants whose farms would steadily increase crop output and predicted the need for rail shipping to market. Hill determined to be fully in control when the new homesteads began to produce. To secure his dominance over the rail line and eliminate competitors who might wish to cash in on the improving fortunes of the company, Hill endeavored to

suppress notice of the line's slowly improving earnings in 1877.

By 1878 the line was still in bankruptcy, with Hill as its effective, if highly unofficial, operating executive. In this capacity, he directed construction of a leg that tied the SP&P to the mammoth Canadian Pacific Railroad, thereby establishing a link from the grain lands of Manitoba to the Mississippi River. Finances for this venture came from sales of the St. Paul & Pacific's five million acres to new homesteaders at $2.50 to $5.00 per acre. As Hill expanded his control over the railroad, he established important alliances with other industrialists and financiers; his partner, Canadian George Stephens, was able to secure a much-needed capital infusion from the Bank of Montreal where Stephens was an agent.

Hill's gamble paid off in 1879, when company earnings tripled as the rail line became the beneficiary of an enormous crop yield of thirty-two million bushels of grain, all needing transport to urban markets. Hill and his partners renamed the line the St. Paul, Minneapolis & Manitoba (SPM&M) and were able to capitalize the burgeoning transportation giant at $31,486,000--$15 million in stock, the rest in bonds.[4]

Hill underscored this massive achievement by concentrating on key strategies to build his new business. He actively recruited immigrants from Europe, underwriting their passage to what he considered to be "his" fertile farming region. He expanded business through high volume and low rates and steadily improved shipping capacities by learning engineering principles that allowed him to work with his land surveyors to develop the simplest track lines at the cheapest costs. He developed a thorough knowledge of locomotive design and worked alongside engine builders to construct the largest and most powerful steam engines of the era. He worked cooperatively with new grain merchants, such as the Cargill family, to establish a complex system of country and terminal elevators lining the SPM&M tracks. Hill then combined that distribution system with a fleet of Great Lakes steamers to move the region's produce beyond St. Paul to the Great Lakes and from there overseas. By the early 1880s, just under a decade after he began, Hill had transformed his railroad into a major transportation empire.[5]

Between 1883 and 1885, a general recession caused the rail line's profits to decrease. The heavy flow of grain traffic from Manitoba and to the Canadian west had dropped off. To raise funds for new development, SPM&M decided to increase its stock offerings. In July, 1883, the shares had taken a precipitous plunge as rumors arose that senior partners were going to sell

out to eastern interests organized by Cornelius Vanderbilt. That was untrue, especially given the concentration of control over the stock by Hill and his partners. To improve their control, in August, 1883, the stockholders approved plans for consolidating all of the affiliated lines owned by the St. Paul but operating as quasi-independent entities.[6]

Hill continued to expand the railroad empire. He pushed his rival Henry Villard, head of the Northern Pacific Railroad, to the brink of personal bankruptcy and assumed effective control over that line upon Villard's resignation. Hill then cast his eye eastward. The Chicago, Burlington & Quincy (the "Burlington") was his next choice to become the feeder line into his existing railway complex, although it was a cooperative agreement rather than a purchase. Hill established a virtual transportation monopoly very quickly. He no longer had to encourage new business by luring farmers to his rail line through cheap rates. As usual with monopolists, Hill could now set very high rates because farmers no longer had other options for shipping their goods. The man once revered for encouraging small farmers, quickly became as despised as the plagues of nature, particularly when it became obvious that his 1883 profits would be ten times those generated in the rail line's first year of operation.[7]

Despite such rapid success, the St. Paul, Minneapolis & Manitoba still had financial pressures. However, such strains did not stop Hill from developing new subsidiaries, one of which, the Island Railway Company, began in 1883. This tiny subsidiary appears to have been primarily a paper company established to acquire property. In Buffalo there were two property transactions along the Blackstone Canal in 1883, both of which involved the Island Railway. Pennsylvania Coal transferred two parcels to Island Railway (variably called Island Railroad), while a third parcel was sold to Island in 1890. Two years after the latter transaction, Union Dry Dock sold a fourth parcel to Island Railway in February, 1892. These four lots comprised a coherent tract of land--part of lots forty-six, forty-seven, and forty-eight of the Holland Land Survey.

The whole tract became the site for the Great Northern Elevator built in 1897. The tracts of land were never officially transferred to Great North Railroad even upon the construction of the elevator. However, in 1900, a lease from Great Northern back to Island Railroad confirmed the dominance of Great Northern as the primary owner. The 1900 lease was signed by W. C. Farrington on behalf of both companies. It is clear that as early as 1883 James J. Hill had aspirations to enter the eastern and western

rail operations and that the Island Railway property was his toe-hold at the eastern end of the Great Lakes.

The first active presence of the Great Northern as an operating company in Buffalo did not occur until 1889, the year both the Island Railroad Company docks and the Northern Steamship line appear as Buffalo businesses. By 1897 the Island Railroad was gone and only the Great Northern Elevator existed along with the steamship line.[8]

The years after the recession were turbulent for the railroad company. Hill had diversified his board of directors, but its ties to large finance capital made loyalty to Hill suspect. To prevent the kind of corporate raiding on SPM&M that Hill himself had engaged in with respect to other rail lines, Hill worked once again to consolidate control over the company's stock and to assure his own voting control over matters of policy. Once again, Hill was forced to become more competitive, this time not only to increase traffic volume, but also to lower the stock's attractiveness by reducing its market value. To that end, he granted tariff relief to farmers and restricted new growth in the hope that both outside interests and his untrustworthy inside directors would look elsewhere for a takeover opportunity. As a by-product, Hill also hoped that volume would increase, but the latter goal was not realized. Rates were reduced 25 percent but traffic remained static.

The railroad reduced its quarterly dividend and established a reserve fund. In 1884 the board voted that all revenues over costs by 6 percent per year dividend would be placed in the fund. Consequently, in 1885 bonds sold in New York were languishing and new investors were scarce. Boston investors involved in the Burlington now wanted to consolidate their westward connection with the SPM&M to which Hill assented, since he remained in control. Simultaneously Hill decided to dissolve a more restrictive relationship with the Canadian Pacific of which he was a director but not a controlling owner. The two lines' agreement to cooperate yet compete freed Hill from having to underwrite the Canadian Pacific's operations. That dissolution further encouraged the Burlington's investors to underwrite Hill's enterprise, which could do business in a less encumbered atmosphere.[9]

Despite his sophisticated maneuvering with respect to railway coordination, the 1880s were a difficult time for Hill. Consent agreements with the other lines, capital formation with friendly banks, and reorganization were complex maneuvers. Bold in some operations, cautious in others, Hill and his board of directors had to determine which programs to undertake in an era

of sluggish recovery and uncertain politics. These structural limitations no doubt account for the time lag between the initial purchases of property in Buffalo and its actual development; other decisions had to be made and other steps had to intervene before this large western railroad could embark on eastward expansion.

The first critical link was strengthening grain handling and distribution systems. In 1886 SPM&M moved to the head of the Great Lakes in Superior, Wisconsin, where the company built a grain elevator that was leased to a new subsidiary, the Great Northern Elevator Company. Hill then sought an independent entry to Superior and nearby Duluth, Minnesota that would supplement the existing rail line. He announced, and the board supported, the development of a fleet of lake steamers that would ply the Great Lakes between Duluth and Buffalo.

The only bar to Hill's successful operation of a rail line competitive with the giant eastern and western railroads had been the rates of other lake vessels and the control Chicago-based and eastern rail lines had over rates outside his immediate jurisdiction. Hill had no choice but to enter lake commerce with his own fleet. Northern Steamship was formed in June, 1888, and by 1889 Hill's six steamers carried 42 percent of the flour going west from Duluth, while the railroad to Duluth remained a virtual monopoly. Hill had by-passed the trap of dependence upon other, unfriendly carriers to become a superpower in his own right.[10]

The greatest obstacle to Hill's expansion plans came not from competition with other lines and steamship companies, but from his own financial backers and the directors on his board. The latter were concerned about a potential general panic and about a shaky financial market already flooded with railroad bonds. Although too many rail companies were accused of "laying rails to carry bonds, not freight," the St. Paul, Minneapolis & Manitoba was not one of them. With his banks loathe to increase the company's indebtedness, the logical alternative was to issue another sale of stock. This Hill rejected; the more outstanding shares available for sale, the greater the risk of stock being purchased by enemies and competitors who would cost him control over the company.

By contemporary standards, the SPM&M shares were closely held; there were 150 owners in 1885 and still only 750 in 1889. But even this modest expansion was worrisome to Hill. His debate over whether to expand, and therefore how to finance the growth, was decided for him with the advent of yet another depression. Hill determined correctly that the downturn was likely to last at least five years, and plans for growth were shelved.[11]

These factors all contributed to Hill's decision to delay entry into eastern markets and even into open competition for a midwestern rail line. In 1893, however, a new ally joined forces with Hill and radically altered the western rail company's growth. In 1889 the company had changed its name, taking the title of the Superior, Wisconsin grain elevator as that of the entire system. The majestic "Great Northern" became the corporate appellation for the whole of Hill's operations. The name was apt since the Great Northern had eclipsed virtually every other western line save the Union Pacific. Despite depressions, intractable financiers, and a multitude of other problems facing his expansion plans, James J. Hill had become a formidable presence within American capitalism.

His chief opponent was New York financier J. Pierpont Morgan who directly and indirectly controlled 45-50 percent of the nation's railroad mileage through his control of bank loans to a myriad of transportation companies. Morgan had undertaken to refinance the chronically bankrupt Northern Pacific, which was managed but not controlled by Hill. By the 1890s, Hill was too powerful for Morgan to break and too competent for him to ignore. Soon the two men joined together to exercise unified control over the western lines.[12]

With Morgan's backing, Hill pursued several key projects that had been forsaken over the prior decade. Hill's push for eastern grain markets began with his steamship company but could not be fully realized until he had a terminal elevator at the eastern end of the Great Lakes. In 1897 the company once again hired architect Max Toltz, designer of the Superior, Wisconsin and Duluth, Minnesota elevators, to create the new grain storage facility for Buffalo due to be erected on the Island Railway property. The new structure was of novel design and more complicated to build than the earlier Toltz plans, but Hill raced to complete the construction before the end of the 1897 shipping season. Construction took only six months, start to finish, and the first cargo reached the elevator September 29, 1897, aboard Northern Steamship's SS North Star. The company had not bothered to incorporate in Buffalo until only six days before, a testament to Hill's disdain for legal formalities and belief in his own power.[13]

Hill's personal direction of both the design and construction standards is a well-propagated legend without any clear foundation. The literature of his day certainly asserted his central role, but the accuracy of the contentions cannot be proven. Regardless of whether or not Hill was the technological and engineering whiz he himself purported, his influence as head of the company is indisputable. There remains, embodied in the

elevator itself, a possible tribute to his command; the visible ends of the elevator's tie rods, generally fashioned in round or star shapes, are instead crafted in the form of the letter "H."[14]

Although the Great Northern shut down soon after its gala opening for the traditional winter season, it reopened the following spring with the kind of flair expected of a J. J. Hill enterprise. In early May of 1898, the elevator received the most valuable grain cargo ever brought to Buffalo. The Great Northern took in a single shipment of 210,539 bushels of wheat assessed at $1.30 per bushel.

The Great Northern Elevator turned out to be a mixed blessing for Hill and his railroad. He had embarked on the Buffalo venture as a way of reducing elevator charges on his grain shipments paid to other elevator owners. The Great Northern Elevator did reduce Hill's costs for scooping and storage, but his satisfaction did not last. One obstacle was the crowded condition along the riverfront restricting railroad car movement and impeding the progress of stored grain to New York City. He later calculated that the overall costs of land and construction were far too high for the per-bushel price at Buffalo to be competitive, especially when transportation costs were added.[15]

Simultaneously Hill was once again engaged in a titanic struggle for railroad dominance. In May, 1901, Hill became locked in battle with the country's other great railroad magnate, E. H. Harriman, owner of the Union Pacific and the Southern Pacific lines. Longtime rivals, the two men were in a formidable race for dominance over the Northern Pacific Railroad. Hill's and Harriman's "seconds" in the duel were the financial houses of, respectively, J. P. Morgan and Kuhn, Loeb & Company. Hill raced to New York City on May 3, only to discover that Harriman already had controlling interest over the Northern Pacific preferred stock.

Through J. P. Morgan, however, Hill set out to gain the majority of the more critical common stock which still could give him dominance over the operation of the rail line. Harriman caught wind of Hill's interest, and the two battled for days to corner the stock and gain the upper hand. The stock value soared from $140 to over $1,000 per share in a frenzied bidding war. The price floor under other stocks collapsed, ultimately bringing the Northern Pacific stock back down as well but undermining those who had bought large quantities at high prices. Harriman finally won out, forcing Hill and his backer, J. P. Morgan, into a compromise giving Harriman representation on both the Northern Pacific board of directors and on Hill's Burlington line. The

bidding war had hurt Hill financially with far less return.[16]

While J. J. Hill was far from destitute, the Northern Pacific fiasco undoubtedly made him considerably more fiscally cautious. His impatience with Buffalo as a grain transfer and storage site was increasing. In 1903 he was made an offer he could not ignore: a combination of several eastern rail lines proffered an impressive profit for the property and later the stock of both the Great Northern Elevator and the steamship line for which it was named. Island Railroad, the Great Northern subsidiary that bought the lots upon which the elevator was built, was exempt from the initial sale made March 4, 1903. By September, however, the same syndicate that bought the elevator had acquired the rail spur line company as well.

The Mutual Elevator Company which bought the Great Northern included Wall Street financiers William Anderson, Origen Seymour, Theophilus Parsons, and Philip Huetwohl, as well as Buffalo attorney Henry Sprague. The Island Railroad Company was incorporated by James Stevenson, John Middleton, Charles Goldsborough, and Frank H. Silvernail among others. All of these men were directly employed by or interlocked with major eastern railroads, primarily the New York Central, the Lake Shore & Michigan Southern, the Erie, the Delaware, Lackawanna & Western, the Lehigh Valley, the Atlantic & Great Western (later the New York, Pennsylvania & Ohio), and even the Missouri Pacific. The Pennsylvania Railroad was a more "silent" partner. All of the rail lines represented in the Mutual Elevator, the steamships, and the railroad spur, stood to benefit enormously from the captive grain traffic the elevator would provide on the haulage to Buffalo and then to eastern port cities. The takeover was a major coup for those railroad interests.[17]

The presence of the railroad consortium was an extension of a long-time battle between local grain traders and the railroads that owned or otherwise controlled much of the land around Buffalo's waterfront. The very railroads that had too often gouged grain traders without transportation affiliates now possessed one of the city's paramount elevators. They clearly had a significant advantage over small grain elevators, gleaning preferential storage as well as haulage rates. It was in this period that a good number of Buffalo's smaller elevators went out of business, although very little documentation exists to indict unfair practices as the sole cause. Nevertheless, the Mutual flourished for eighteen years, even as the landscape of Buffalo's riverfront saw the decline of small, once-flourishing elevators and the elimination of many prominent local names from the competition.[18]

Throughout the years that Mutual Elevator (later Mutual Terminal Corporation) owned the Great Northern, the company put very little into the elevator in the way of expansion or improvements. Despite the lack of capital infusion, the railroad consortium certainly used the elevator as a source of non-productive revenue. One month after acquiring the elevator, Mutual stockholders authorized a $5 million, fifteen-year 4 percent mortgage on the property drawn on J. P. Morgan's Guaranty Trust in New York City. Guaranty Trust issued the loan in variable amounts over the next twelve years with the sums declining as time went on. At no point do records indicate that Mutual satisfactorily repaid the loan, backed by bonds, and that use of the elevator as a "cash cow" may have led to the sale of the property and the ultimate dissolution of the company in 1921 and 1923 respectively.[19]

In 1921 Mutual sold the elevator and its property, including the Island Railroad rights-of-way, to a local Buffalo group named the Island Warehouse Corporation. This organization, formally chartered June 7, 1921, entered into the sale agreement on the property twenty-two days later. Island Warehouse was comprised of the three men who had already made their mark on Buffalo's grain business through the establishment of several very important elevators including Concrete-Central--Nisbet Grammer, John T. Rammacher, and Edwin T. Douglass. Although the purchase price from Island to Mutual was not disclosed, Mutual must have been seriously damaged in the transaction since Island Warehouse required only a $600,000 mortgage to cover the transaction, a far cry from Mutual's $5 million debt. Clearly, the mere fact of size and advantage did not necessarily make the railroad consortium good grain traders and handlers.[20]

Despite the owners' extensive experience in operating grain elevators, Island Warehouse spent little time developing its own line of business for the Great Northern. Instead, the Buffalo company established a complex relationship with one of the nation's true grain trading and milling giants, Pillsbury Flour Mills Company. Island sold 100 percent of its stock to Pillsbury, all the while retaining control of the elevator, the flour mill, and the property. These, in turn, were leased to Pillsbury on a twenty-five year agreement that began May 1, 1923. Island had taken a much larger, $5 million mortgage just a little less than two months before the lease agreement was signed and clearly retained the legal obligation to make payments on the mortgage on behalf of Pillsbury's continued smooth operations at the site. In return Pillsbury paid Island $237,780 per year. Apparently the financial burden upon Island was greater than the remuneration. In 1935 Island sold the property outright to Pillsbury, before filing for dissolution six months later as the

result of legal actions ordering payment schedules the company had difficulty meeting.[21]

Pillsbury's history is one of convoluted ownership patterns coupled with a clear, linear progression in business operations. The company was founded in 1869 in Minneapolis by Charles A. Pillsbury who began his business by leasing a small, 400-cwt mill. Charles was supported in his business by his uncle, a hardware merchant and later a three-term governor of Minnesota and a founder of the state's university. Charles Pillsbury's father was a trolley operator. The elder Pillsburys were owners but did not involve themselves in the mill's operations. By 1878 the younger Pillsbury had substantially enlarged the mill and had built the Pillsbury "A" mill, then the largest in the world. His success was due, in part, to his interest in technological innovation and adaptation. The Pillsbury Mill was among the first with the capacity to grind hard northwestern wheat into the soft, white flour desired for its finer texture in fancy baked goods. By 1886 Pillsbury was doing $15 million in business annually and was probably the largest milling company in the world.

Three years later, the Pillsbury Company was acquired by a British financial syndicate. Pillsbury was merged with other American milling firms owned by Senator William D. Washburn to become the Pillsbury-Washburn Flour Mills Ltd. There was no relationship between the senator and the Washburn family in the early formation of General Mills, but both sets of Washburns established large and powerful milling combines in the state of Minnesota.

After the death of C. A. Pillsbury, head of the company from 1889 to 1899, Pillsbury-Washburn was beset with financial problems. It was dangerously overcapitalized, which meant increasingly large proportions of income had to be directed toward shareholder dividends. Then, in 1907, the company faced a damaging crop shortage that eradicated much of its flour production. Seriously short of cash, in 1908 the company went into receivership. On June 23 of that year it was reincorporated as Pillsbury Flour Mills Company to absorb the liquid assets of Pillsbury-Washburn and to run the mills under a lease agreement with the British company. The arrangement lasted until 1923, when Pillsbury formally acquired title to the real estate and other tangible and intangible assets of Pillsbury-Washburn. The next year Pillsbury became a publicly-traded company with somewhat greater public accountability, and its improved financial picture allowed Pillsbury to begin expansion programs again. Part of that effort included establishing milling operations in Buffalo.

In 1928 Pillsbury dissolved its New York charter to reorganize with a Delaware incorporation seven years later as Pillsbury Flour Mills Company. At that time it acquired the assets of Pillsbury Flour Mills, Inc. and all of its subsidiaries, including Island Warehouse, which was dissolved under difficulty the following year. Despite the Depression and general agricultural slowdown, Pillsbury fared well during the 1930s and entered the war years with a strong market and financial position. In 1944, after a series of acquisitions, the company was again called Pillsbury Mills, a name lasting until 1958 when it became Pillsbury Company. In addition to flour milling, the company's only operation in Buffalo, Pillsbury added the production of baking mixes, refrigerator dough products, snacks, and other consumer food lines. By the 1960s, the company owned restaurants and extended its line of merchant goods designated for bakeries, restaurants, and institutional food preparers. The company also extended its holdings overseas in South America and in Europe.[22]

On January 3, 1989, Pillsbury was once again acquired by a British financial conglomerate, Grand Metropolitan. Grand Met, as it is familiarly called, has no particular business focus outside of acquisitions, but its line of businesses tends toward operating licensed premises such as inns, hotels, and restaurants and buying companies that provide food, drink, and luxury items for consumers. Grand Met remains Pillsbury's owner to date.[23]

Pillsbury's tenure in Buffalo continues to the present time, although the Great Northern Elevator is idle. Upon its own internal assessment, the company decided that the original brick structure was unsound and abandoned the facility in 1981, when it replaced the Great Northern's functions with the nearby Standard Elevator. The Great Northern has not been used for grain storage since that time. In recent years the elevator has become a focus for historic preservationists, but to date no significant suggestions for adaptive reuse or rehabilitation have been made. The structure's demolition would be a great loss of a unique and historically significant landmark.

MATERIALS HANDLING: HISTORY AND DESCRIPTION

Receiving by Water

Original equipment for unloading grain from vessels moored in the Blackwell (City) Ship Canal consisted of three marine towers, each containing a leg capable of elevating 20,000 bu./hr. Rolling on sixteen pairs of truck-mounted wheels, the towers traversed a masonry dock, 24' in width, along a pair of 94-lb. T-

rails; these standard gauge tracks were supported by I-beams resting on subterranean stone rib arches. Each tower could shift its position along the dock at a rate of 15' per minute. through a cable haulage arrangement. Power was supplied by a 50 hp motor with worm gear reduction drive located on the ground floor of the elevator. Since the towers could be maneuvered independently, they could be aligned to unload from three hatches simultaneously, giving a nominal overall transfer capacity of 60,000 bu./hr. from ship to elevator.

The dimensions of each tower measured 20' x 30' at the base, 20' square at the top and 125' up to the apex of the hip roof. The structural framework consisted of upright channel columns with diagonal bracing and a sheathing of corrugated iron. Despite weighing in excess of 150 tons, the towers demonstrated considerable instability in high winds and were attached to a track in the elevator wall, located about 100' above the dock. Each marine leg, housed within its respective tower, consisted of a double box girder with diagonal bracing. The head pulley, 72" in diameter, and the 18" boot pulley were spaced 86' apart. Running around the pulleys and through the box girder framing, a 19" seven-ply belt with 30" x 8", 9" deep galvanized steel buckets carried grain from a vessel's hold up into the tower for weighing.

In operation, a 100 hp motor located on the first floor of each tower powered the marine leg through a rope drive to the distant head pulley. This motor also powered the hoist that lifted the counterweighted leg out of the hold when required, as well as driving the power shovels used for moving grain to the boot pulley. A screw-drive pusher on the second floor controlled the lateral travel of the leg as it moved out from the tower and over the ship. Grain raised by the marine leg discharged into a 300 bushel garner and was then weighed in a 250 bushel scale below. Weighing was carried on in 200 bushel lots.

Since the original marine towers did not feature internal lofter legs, instore grain was discharged at a relatively low level rather than at the top of the storage tanks. From the second floor of the marine towers, the contents of the scale hoppers flowed by gravity into a trough or series of receivers situated along the west brick curtain wall of the elevator. From these points grain was spouted down into the boot tanks of the multiple house lofter legs for the trip up to the cupola.

At least three of the Great Northern's original marine towers were replaced during the mid-1920s by upgraded units, two of which remain in place on the rebuilt dock. Visual evidence suggests that the newer towers coexisted, with one surviving 1897 model. Monarch Engineering Co. of Buffalo designed and

constructed the replacement towers to incorporate incremental improvements in power transmission. However, constraints posed by the elevator's structural and functional characteristics dictated some deviations from the standard practice represented by other marine towers surviving from the 1920s. The Monarch towers stand 144'-7" high and measure 30' x 19' in plan. By the late 1930s, nominal marine receiving capacity through the upgraded towers was rated at 45,000 bu./hr. Shortly thereafter, the increasing dimensions of lake vessels generally precluded simultaneous unloading by more than two towers; the elevator's maximum marine receiving capacity declined further to 25,000 bu./hr. During the last years of operation, nominal marine unloading rates sank to 10,000 bu./hr. per leg or 20,000 bu./hr. overall.

Receiving by Rail

In contrast with the relatively prodigious handling rates of its marine towers, the Great Northern's original capability for unloading grain from rail cars was decidedly modest; the Hill interests presumably contemplated receiving the vast preponderance of shipments to the new terminal via laker. To facilitate the spotting of rail cars, the elevator was equipped with a 50 hp motor, located on the ground floor, which also performed double duty for the cable haulage system that moved the marine towers.

Car switching was accomplished through an underground cable to nearby rail yards; the maximum rate of car movement was 90' per minute. A single track entered the elevator from the north and ran along the east wall in a slight depression. A portable power shovel operated by a 10 hp motor was used in unloading the cars. Whether grain could be transferred directly from the cars to the elevator boots remains undetermined but appears unlikely. It was anticipated that the portable shovel would also be capable of clearing excess grain accumulated on the ground floor at the close of the navigation season. Rail receiving may therefore have involved a two-step process--from car to floor and from floor to lofter leg boots.

By the mid-1920s the practice of unloading cars inside the house appears to have been discontinued. Great Northern's rail receiving equipment at that point consisted of a single car pit, presumably including a set of conventional power shovels and, perhaps, a belt conveyor to at least one of the house lofters. This arrangement would have dedicated a house leg to specialized receiving, as distinguished from the dual shipping-receiving functions inherent in the original D. A. Robinson design. Nominal rail unloading capacity during this period was rated at only two cars per hr. At the close of the elevator's active life,

the comparable receiving rate had risen to eight cars per hr., possibly indicating further improvements of an undetermined nature.

Receiving by Vehicle

As of 1897, the Great Northern featured no capacity for handling grain arriving by wagon. However, during the course of subsequent modifications, provision was made for receiving 4,500 bu./hr. by truck. These undetermined arrangements may have involved use of the car pit.

Instore Distribution: Horizontal Transfers and Vertical Handling

Grain received via either lake or rail was lifted to the cupola atop the storage bins by a set of ten internal lofter legs. Nine of the legs passed upward through the interstices between the west row of intermediate (15'-6" diameter) storage tanks and the center row of large (38' diameter) tanks. The remaining lofter was situated at the north end of the building between the central tanks and the east row of intermediate tanks. The double lofter arrangement at the north end may have been designed to facilitate shipments out via the canal slip or, perhaps, rail receipts. Each lofter originally stood 168' high. The house legs carried a double row of 640 30" x 8", 9" deep buckets attached to a 32" six-ply rubber belt. Each bucket could hold about eighteen lbs. of wheat. The legs were capable of raising 20,000 bu./hr., each at a belt speed of 636'/min.

Power transmission to the lofters was one of the distinguishing characteristics of Great Northern's original equipment. Each leg was driven by an independent 50 hp motor through a variant of the single-leg rope drive system first patented by Robinson and John Simpson in 1891.[24] Nine of these motors were aligned along the west wall of the scale floor in the cupola; the tenth motor was located opposite the northernmost leg. The driving ropes ran in grooved sheaves. Speed reduction was accomplished through pinion gears located on each sheave and the corresponding leg countershaft at the head pulley of the individual lofters.

Grain elevated for weighing and distribution to storage or shipment without cleaning discharged through turnhead spouts at the head floor of the cupola and dropped into one of ten garner-scale sets. All these weighing units were situated in a continuous row and each corresponded to a particular lofter. The capacity of the garners was about 1,600 bushels and that of the Fairbanks scales approximately 1,200-1,400 bushels. After weighing, the scale was emptied by opening a lever-operated slide valve mounted upon rollers.

The contents of each scale discharged into one of ten universal distributing spouts. By the time of the Great Northern's construction, double-jointed swiveling spouts had commenced to supersede the multitude of fixed spouts which had previously given elevator distribution floors the visual appearance of a dense forest. Edward D. Mayo had patented perhaps the most common version of the universal spout in 1891.[25] In devising a patented spout for installation in the Great Northern, Robinson employed a trussed center pole with braces to support the various sections as distinguished from the circular track used by Mayo.[26] An operator could swing the extended spout to reach any bin within a 37' radius.

A pair of belts running longitudinally over the distribution floor provided a means of access to bins lying beyond the reach of a given universal spout. A reversible 20 hp at 750 rpm motor at the north end of the floor drove each conveyor which consisted of a 60" five-ply rubber belt approximately 740'-800' in length, running over terminal pulleys and supported at intervals by idlers. Each conveyor was equipped with concentrators to minimize spillage at discharge points from the spouting system. Two mobile four-pulley trippers transferred grain into the desired tank. At a speed of 1,000' per minute each conveyor had a rated capacity of 40,000 bu./hr., the most rapid mechanical handling capability of any elevator in the world in 1897.

There have been some modifications to the original equipment used in the instore distribution sequence. Perhaps the most noticeable change involves the elimination of the Robinson patent rope drive on the lofter legs. The motors, including several of the original units, are now located on the attic floor of the cupola and drive the lofters at the head pulley through reduction gearing. However, the scales and patented distribution spouts remain essentially intact.

Grain Conditioning

As of 1897 grain received by water or rail that required cleaning was lifted to the cupola via one of the ten lofting legs inside Great Northern. However, instead of discharging into one of 1,600 bushel garners described previously, the flow was diverted into 900 bushel garners supplying the cleaning machinery; a total of seventeen such garners occupied space in the cupola. Original cleaning equipment consisted of four No. 9 Monitor Separators furnished by the Huntley Manufacturing Co., then located in Silver Creek, New York. These machines were installed on the scale floor of the cupola. A motor rated at 100 hp at 500 rpm, located on the same floor, drove the cleaners through a countershaft with belts to individual units. From the

cleaners, two Robinson universal spouts distributed grain to storage routes or shipping bins. Subsequent additions to or replacements for the original cleaners remain undetermined.

Dust Control

Another pathbreaking feature of the Great Northern was the extensive provision for collecting and disposing of particulate matter arising from the course of normal operations. The unprecedented arrangements consisted of pneumatic dust collectors and sweepers with independent systems located upstairs in the cupola and downstairs on the ground floor. The dust collecting apparatus relied on low-speed fans to remove finer particles at the principal points of discharge; the sweeper system used high-speed, 3,000 rpm fans for handling larger pieces of foreign matter. Upstairs equipment included a double 60" fan, located on the top floor of the cupola, to clear dust from the lofter heads and garners as well as a double 50" fan on the bin floor to operate the upper sweeper system. Downstairs equipment included a single 70" fan connected to the lofter leg boot tanks and a double 45" fan for the lower sweeper system. The upstairs fans were driven by the same 100 hp motor that operated the cleaners. The 50 hp marine tower/car haul motor drove the downstairs fans. Each marine towers was equipped with comparable fans for dust removal. Sweepings were discharged into the adjacent waterways. Replacements for original equipment remain undetermined.

Shipping Out by Rail, Water and Vehicle

As a terminal house designed for rapid intermodal transfers among water, rail and land transportation systems, balanced receiving and shipping capacity was a primary consideration in the design of Great Northern. As noted above, the maximum unloading rate through the marine towers was 60,000 bu./hr. or 600,000 bushels over a normal working day of ten hours. Loading rates out were projected--perhaps optimistically--at 400 cars per day via rail, 100,000 bushels per day to canal boats, and 200,000 bushels per day to Welland Canal vessels; wagons hauling grain for local delivery could also be accommodated.

All four sides of the elevator were used in the original scheme for outstore loading. Grain was drawn from storage through hoppers in the bottoms of the main and intermediate tanks and conducted to the house lofter boots through portable spouts. Following elevation to the cupola and discharge into a garner, the shipment was weighed in drafts proportioned to the size of the car or vessel being loaded. The ten outstore scales could weigh up to 78,000 lbs. in a single draft.

Distribution to the appropriate shipping bins, situated between the walls and main tanks, was accomplished through the spouting system or via the bin floor conveyors to more distant points. Rail cars were loaded on a double track under a steel canopy along the east side of the elevator. Nine 1,400-1,500 bushel shipping tanks situated 60' above ground level delivered to cars spotted below through long bifurcated spouts. As of 1915, the record for loading cars stood at 120 over a five hour period. Through a similar sequence, grain could also be distributed to nine 3,200-bushel shipping tanks of identical diameter on the west wall for loading boats sized to fit the locks on the Welland and St. Lawrence canals. Four 6' in diameter, 1,000-1,100 bushel tanks on the south wall were reserved for wagon shipments.

Facilities for delivery to Erie Canal barges moored in the north slip were more extensive. Four sets of garners and 160 bushel outstore scales were arranged to operate in conjunction with the paired lofter legs previously described. The four canal shipping tanks, each 8' in diameter, held 450 bushels. Contemporary opinion maintained that large-capacity shipping tanks facilitated efficient transfer operations by permitting uninterrupted weighing even as cars or vessels were being shifted. Besides drawing grain from storage, direct transfer from lake vessel to car or barge was also possible via the sequences which have been described.

Alterations to original shipping arrangements include elimination of the north end garners, scales and shipping tanks. Two of the wagon shipping tanks apparently remain extant, as do the rail and dock shipping tanks. Following the elevator's conversion from a transfer house to storage for Pillsbury's adjacent flour mill in the mid-1920s, nominal marine loading rates were listed as 15,000 bu./hr. using a single spout; rail loading could be carried on at the same rate using eight spouts to four tracks. At the close of active operations, marine loading rates had fallen to 11,000 bu./hr. Rail shipments had declined from 150 cars every ten hours to fifty cars around 1940 and thirty-two cars every eight hours by 1961. Truck loading capacity during the 1970s was 4,500 bushels per day.

ENDNOTES

1. The following paragraphs are based on several sources including plans and building permits housed in Buffalo City Hall and plans drawn by D. A. Robinson and Max Toltz now in the possession of the Pillsbury Company. Additional information can be found in the following contemporary journals: American Elevator & Grain Trade 16 (15 December 1897): 205; Northwestern Miller 45 (4 February 1898): 174; Scientific American LXXVII (25 December 1897): 406; Engineering News XXXIX (7 April 1898): 218; Electrical Engineer XXV (27 January 1898): 100; and Electrical World 31 (12 February 1898): 211-215.

2. Iron Age 60 (19 August 1897): 4.

3. Buffalo Express, 10 May 1897, p. 9.

4. Matthew Josephson, The Robber Barons (New York: Harvest Books, Harcourt, Brace & World, Inc., 1962), 231-39; Ralph W. Hidy, et al., The Great Northern Railway: A History (Boston: Harvard Business School Press, 1988), 2, 30-34.

5. Josephson, The Robber Barons, 236-37.

6. Hidy, et al., The Great Northern Railway, 48-51.

7. Josephson, The Robber Barons, 248-49.

8. Erie County Clerk (ECC), Deeds, Liber 448, October 3, 1883, 276; Liber 457, December 18, 1883, 43; Liber 557, March 14, 1890, 312; Liber 597, February 17, 1892, 182; Buffalo City Directory, 1889, 1897. I am indebted to Robert Frame and John Wickere for unearthing information concerning the Island Railway as a St. Paul, Minneapolis & Manitoba subsidiary and determining its date of incorporation as 1883. These papers are otherwise hidden in the James J. Hill papers in St. Paul, Minnesota. All Erie County Clerk documents are listed by date of document origin, not by date of filing, unless otherwise noted.

9. Hidy et al., The Great Northern Railway, 50-54.

10. Hidy et al., The Great Northern Railway, 63-67.

11. Hidy et al., The Great Northern Railway, 68, 70.

12. Hidy et al., The Great Northern Railway, 72-73; Josephson, The Robber Barons, 416-17.

13. ECC, Corporations, Great Northern Elevator Co., Certificate of Incorporation, September 23, 1897, Box 7142; Iron Age, 60 (19 August 1897): 4; Buffalo Express, 10 May 1897, 9 and 28 September 1897, p. 9; Engineering Record, 27 November 1897; Scientific American, lxxvii (25 December 1897): 406-7; Northwestern Miller, 45 (4 February 1898): 177-8. The rapid construction was not without its human costs. As the September 28, 1897, Express story shows, three men were killed in four days in falls from the top of the elevator during the haste of construction.

14. See for example The Electrical Engineer, 25 (27 January 1898): 99-100 and Northwestern Miller 45 (4 February 1898): 175.

15. Buffalo and Erie County Public Library (BECPL), Scrapbooks, "Buffalo Harbor," v. 2, 42-44.

16. Bernard Baruch, Baruch: My Own Story (New York: Henry Holt and Company, 1957), 133-49.

17. ECC, Corporations, Mutual Elevator Company, Certificate of Incorporations, February 28, 1903, Box 12,232; Island Railroad Company, Certificate of Election of Directors, September 8, 1903, Box 7635; Deeds, Liber 987, March 4, 1903, 202; BECPL, Scrapbooks, "Buffalo Harbor," Vol. 1, 324-25.

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19. ECC, Corporations, Mutual Elevator Corporation, Consent to Mortgage, April 30, 1903; Annual Statement: Mortgage, July 31, 1915; Certificate of Dissolution, December 11, 1923, Box 12, 232.

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25. U.S. Patent #464,101, Specifications of Patents (1 December 1891), 142-43.

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APPENDIX

Cost:	$400,000
Foundation:	6000 wooden piles, capped by grillage on which rest 198 tiered stone footings that provide the base for the structural pillars
Basement:	Full height, bins lifted on 28' structural steel columns
Hoppers:	Hemispherical plate steel bottoms riveted together and fastened to the ring girder
Bins:	Steel Capacity 2,500,000 bushels Main bins: 38' in diameter cylinders 70' high, 80,000 bu. in 3 non-interlocking rows of 10 Interspace bins: self-contained cylinders, 18' in diameter, 70'-6" high, 15,000 bu. arranged in 2 rows of 9 Outerspace bins: self-contained cylinders, between outer main bins and brick curtain walling. The west side has 9, 9'-9" diameter, boat shipping bins, of 3,000 bu. capacity; The east side has 18, 9'-9" diameter railroad shipping bins, of 1,500 bu. capacity; the north side has 8, 8' diameter barge shipping bins of 450 bu. each, & the south side has 4, 6' diameter wagon shipping bins of 1,100 bu. capacity; the shipping bins are from 22'-53' high Interspace bins added on or after 1922, 60 elliptical steel bins between the interspace and main bins, 4 placed in the interspace between 4 adjoining main bins Main bins raised on a circular ring girder supported by 8 steel columns; the bins are riveted to the annular girder The main and interspace bins are made up of steel plates bolted together; all components pre-fabricated to be assembled on-site; plates graded in the main bins from 1/2" at the base to 3/16" at the top; interspace bins 5/16" at the base decreasing to 3/16" at the top; bins designed to withstand full hydraulic, rather than grain pressures Bins enclosed within a non-structural brick wall

Cupola: Full cupola, 4 stories high, to a total height of 181'; extends length of building; supported by extensions to the basement columns which pass between the bins; structural steel clad in corrugated iron

Marine Towers: Originally three movable towers 125' high; 2 blown down in 1922 and replaced by two 145' towers; remaining original tower retained but demolished sometime after 1929

REFERENCES: The City Plans Book for 1897 gives the estimated cost of construction, and city building permits provide the dates. Reviews of the building occur in the following periodicals: American Elevator & Grain Trade, 16 (15 December 1897): 205; Northwestern Miller, 45 (4 February 1898): 174; Scientific American, LXXVII (25 December 1897): 406; Engineering News, XXXIX (7 April 1898): 218; The Electrical Engineer, XXV (27 January 1898): 100; The Electrical World (12 February 1898): 211. Original plans by Toltz and Robinson are held by the Pillsbury Company.